

ANNUAL REPORT:
TERROR LAKE HYDROELECTRIC PROJECT
1988 SALMON EGG AND FRY SURVIVAL, ESCAPEMENT MAGNITUDE
AND SPAWNER DISTRIBUTION

By:
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ABSTRACT

The pre-emergent fry indices on the Terror River and Kizhuyak River were generally fair to good. High waters during the fall of 1987 resulted in scouring in both river systems. However spring climatic conditions were mild and an average to lower than average pink salmon return is expected in 1989. The peak indexed pink salmon escapement in 1988 was 124,000 in the Terror River and 39,000 in the Kizhuyak River. The peak indexed chum salmon escapements in 1988 were 15,000 in the Terror River and 27,000 in the Kizhuyak River. These are at or near peak indexed escapements for these rivers since this study began.

Key Words: Terror Lake Hydroelectric Project, Salmon, Oncorhynchus, Pre-emergent fry, Spawning distribution, Escapement

INTRODUCTION

Prior to development of the Terror Lake hydroelectric project potential beneficial and detrimental impacts on the salmon populations of the Terror River and Kizhuyak River were identified (AEIDC, 1981). Changes in stream flow and temperature directly affect salmon spawning and egg survival. In 1981 the Alaska Department of Fish and Game (ADF&G), Commercial Fisheries Division (CFD), entered into an agreement with the Kodiak Electric Association (KEA) to assess the magnitude of change, if any, in the pink salmon (Oncorhynchus gorbuscha) and chum salmon (Oncorhynchus keta) populations in these two rivers. Study began in 1982 to measure pre-project levels of spawning and egg survival and have continued through facility construction and subsequent operations. Specifically, CFD wishes to evaluate (1) salmon egg and fry survival, (2) timing of salmon fry emergence; and (3) trends in salmon escapement magnitude and spawner distribution.

The Terror and Kizhuyak Rivers are located in north central Kodiak Island (Figure 1). The areas of study encompassed approximately the lower 1.5 miles of each river. The Terror River extends some 7.5 miles, running down from Terror Lake (Figure 2). An earthen and concrete dam was constructed at the lake outlet to increase the lake's volume and control outflow. A 5 mile tunnel was drilled to divert water down to a powerhouse in the Kizhuyak Basin.

It should be noted that data collected during the CFD annual studies may not necessarily be conclusive enough to assess specific changes within the salmon populations in question (Malloy 1981). An interim data analysis report will be completed in the fall of 1989, and a final report will be prepared after the end of the study period in 1991. This report details the efforts of CFD during the 1988 season.

PRE-EMERGENT FRY SAMPLING

Methods and Procedures

Pre-emergent fry sampling involved hydraulically excavating sac fry and eggs from spawning habitat. Sampling locations for both rivers are shown in figures 3 and 4. Personnel and equipment were transported to the sites with a Bell Long Ranger helicopter. Ten samples were collected at each pre-selected sampling area. For each sample a circular collection frame, two feet in diameter, was placed on the stream bed circumscribing the area to be excavated. A Homelite XLS pump forced an air/water mixture through a steel probe which was manually worked into the stream bed. All light materials, including eggs and fry, that bubbled up out of the gravel were swept by the current into a tapered net attached to the downstream side of the collection frame. The net

was emptied into a plastic bin and the fry and eggs identified and counted. Fry development, as indicated by the percent absorption of the yolk sac, was noted. A relative index of live fry abundance was developed for each portion of the river sampled.

Results

Terror River

Sampling was accomplished between 25 March and 6 April 1988 and is summarized in (Table 1). The live fry indices for this river were lower than most study years, particularly the upper river sampling sites (Table 2). High water from heavy rains in the fall of 1987 resulted in scouring of the spawning areas. However, spring climatic conditions were mild and an average to less than average return is expected for 1989.

Kizhuyak River

Sampling was accomplished between 13 March and 4 April 1988 and is summarized in (Table 3). The live fry indices on this river were more variable compared to past indices (Table 4). Indices for ADF&G sample sites Beaver Pond Creek were at or near past years average indices. High water from heavy rains in the fall of 1987 resulted in scouring of the spawning areas; however stream conditions allowed sampling below Watchout Creek for the first time and results indicated good over-winter survival. Spring climatic conditions were mild which should result in at least an average return for 1989.

ESCAPEMENT MAGNITUDE AND DISTRIBUTION

Methods and Procedure

Escapement enumeration and spawner distribution mapping was conducted by aerial survey from small fixed wing aircraft (Cessna 206, Supercub). Surveys were attempted twice weekly through the duration of spawning, as weather permitted. On each flight the observer estimated the number of each salmon species in the bays, intertidal zones, and the river systems. Pink salmon season escapements were figured by adding the highest counts 30 or more days apart. For example, for a particular river a high escapement count of 10 August would be added to a high count of 18 September to arrive at a total indexed escapement estimate for the season¹. Chum salmon escapement estimates are made from the peak counts at each system. These counts also serve as a reliable index of total escapements. Both types of escapement estimates are comparable from one year to the next. Spawner

¹CFD calculated indexed escapements for all major pink salmon systems in a similar manner.

estimates are comparable from one year to the next. Spawner distribution was also noted during aerial surveys, and was recorded on a 1:24,000 field map. A foot survey of each river system was to be conducted near the peak of spawning to further document species magnitude and distribution. Unfortunately, because of weather and the extended weir camp operations the foot surveys were not conducted in 1988.

Results

Terror River

Aerial survey data are listed in (Table 5). The indexed pink salmon escapement, estimated by combining high counts made on 4 August and 8 September 1988 was 124,400 fish. This indexed escapement is well above the even-year averages of 67,150 fish (Table 6). The peak chum salmon escapement count was made on 8 September 1988 at 15,000 fish. This count equals the peak count of 1987, both of which are the highest counts observed since the study began (Table 7).

Spawning distribution is shown in Figures 5 and 6. Distribution showed little change from previous years, with spawners utilizing the entire range of spawning habitat (D. Prokopowich, Alaska Department of Fish and Game, Kodiak, personal communication).

Kizhuyak River

Aerial survey data are listed in (Table 8). The indexed pink salmon escapement, estimated by combining high counts made on 4 August and 8 September 1988 was 39,910 fish. This was the highest even-year count since the study began (Table 4). The peak chum salmon count was made on 8 September at 27,500 fish. This is the second highest count since the study began (Table 5).

Spawner distribution is shown in Figures 7 and 8. Chum salmon were well distributed throughout the spawning habitat (L. Malloy, Alaska Department of Fish and Game, Kodiak, personal communication).

Table 1. 1988 Terror River Pre-Emergent Fry Sampling Results

Sampling/Location	Number Samples	Sample Dates	Live		Dead		1988 LF/M ² Index	% Sample W/Fry	Range of Fry Development	H ₂ O Temp.	Comments
			Fry	Eggs	Fry	Eggs					
Lower Terror SW Forks-Tidal	10	4/6/88	454 ^p	0	0	291 ^p	250.17 ^p	60	.05 - .95	2°C	14 sculpin 100 Black Dead Eggs
Lower Terror NE Subtidal	10	4/6/88	490 ^p 493 ^{ch}	0	0	38	263.62 ^p 265.23 ^{ch}	100	.90 ^p .95 ^{ch}	4°C	
Upper Terror Thermograph	10	4/6/88	0	0	0	0	0	0	-	3°C	3 sculpin
Ouzel Creek	10	4/6/88	0	0	0	0	0	0	-	5°C	Chum fry in creek. 227 D.V. fry
Bear Creek	N/S	4/6/88	-	-	-	-	-	-	-	3.5°C	Pond frozen Beaver Dam Frozen
Consternation Creek	10	4/6/88	0	0	0	0	0	0	0	0°C	2 sculpin
ADF&G Sampling Sites Mainstream Terror	50	3/25/88	150 ^p 25 ^{ch}	0 -	0 -	1,185 -	16.14 ^p 2.69 ^{ch}	8	.90	1°C	Signs of scouring evident

Table 2. Comparison of Pre-Emergent Fry Indexes 1982 - 1988 Terror River: Live Fry/M²

<u>Location/Year</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
Lower Terror S.W. Fork Intertidal	17.75p	240.49p	0	70.42 ^p .54 ^{ch}	73.17p	573.51p	250.17p
Lower Terror N.E. Intertidal	569.74 ^p 156.56 ^{ch}	0	371.71 ^p 415.98 ^{ch}	185.61 ^p	0	525.63 ^p 278.81 ^{ch}	263.62 ^p 265.81 ^{ch}
Upper Terror Thermograph	0	15.60 ^p	0	501.95 ^p	0	102.22 ^p	0
Ouzel Creek	8.07 ^p 2.69 ^{ch}	0	2.15 ^p	32.82 ^p	0	64.02 ^p .54 ^{ch}	0
Bear Creek	N/S	.54 ^{ch}	331.74 ^p	0	230.8 ^p	N/S	N/S
Consternation Creek	1.62 ^p	.54 ^p	0	0	0	0	0
ADF&G Sample Sites Mainstream-Terror	25.93p	22.38 ^p	2.04 ^p 5.70 ^{ch}	107.60 ^p	.22 ^p	71.02 ^p	16.14 ^p 2.69 ^{ch}
Kodiak/Afognak ADF&G Combined	224.1p	145.9p	104.54p	252.06p	163.4p	237.56p	204.34p

Table 3. 1988 Kizhuyak River Pre-Emergent Fry Sampling Results

Sampling/Location	Number Samples	Sample Dates	Live		Dead		1988 LF/M ² Index	% Sample W/Fry	Range of Fry Development	H ₂ O Temp.	Comments
			Fry	Eggs	Fry	Eggs					
Lower Chum Channel	N/S	4/4/88	-	-	-	-	-	-	-	3°C	Not sampled Too deep Water backed up from new gravel bar
Kizhuyak-Above Chum Channel	10	4/4/88	0	0	0	1	0	0	-	3°C	Scouring Evident
Kizhuyak 2nd Below Chum Channel	10	4/4/88	10p	0	0	0	5.38	30	.95	3°C	
Kizhuyak N.E. Fork-Tidal	10	4/4/88	116p	0	0	1	62.41	40	.90 - .95	3°C	
Kizhuyak	10	4/4/88	0	0	0	0	-	0	-	4°C	
Kizhuyak Below Watchout	10	4/4/88	506p	0	5	23	272.23	50	.90 - .99	3°C	
ADF&G Sample Sites Beaver Pond Creek	40	3/13/89	1,427 ^P 627 ^{ch}	0 -	62 -	410 -	191.93 ^P 84.33 ^{ch}	40	.30 - .95	3°C	

Table 4. Comparison of Pre-Emergent Fry Indexes 1982 - 1988 Kizhuyak River: Live Fry/M²

<u>Location/Year</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
Lower Terror Channel	393.82 ^p	0	112.98 ^p	76.39 ^p	23.13 ^p	709.08 ^p	N/S
Kizhuyak-Above Chum Channel	22.6 ^p	-	146.87 ^p	1.05 ^p	117.82 ^p	81.78 ^p	0
Kizhuyak River Below Chum Channel	97.92 ^p	5.92 ^p	N/S	N/S	N/S	232.41 ^p	5.38 ^p
Kizhuyak River N.E. Fork	0	1.61 ^p	.54 ^p	266.84 ^p	0	0	62.41 ^p
Kizhuyak River Above Forks/Watchout	0	0	0	N/S	2.69 ^p	38.74 ^p	0
Kizhuyak River Below Watchout	N/S	N/S	N/S	N/S	N/S	N/S	272.23 ^p
ADF&G Sample Sites Beaver Pond Creek	1,042.78 ^p 11.23 ^{ch}	53.8 ^p	493.48 ^p	8.61 ^p	171.22 ^p	1.61 ^p	191.93 ^p 84.33 ^{ch}
Kodiak/Afognak ADF&G Combined	224.1 ^p	145.9 ^p	104.54 ^p	252.06 ^p	163.4 ^p	237.56 ^p	204.34 ^p

Table 4A. Footnotes for understanding salmon escapement data.

Visibility: Indicates water visibility in the following categories:

S=Stream M=Mouth B=Bay A=All three categories or any two categories

Fish in Stream:

- : Stream not surveyed for this species.

0 : Stream surveyed for this species, none observed.

N : Any numerical designation reflects indexed number of live fish observed; portion of stream surveyed includes 100% of fish in stream for survey date. Any deviations from this are denoted in comments, e.g. carcasses and percentage of system surveyed for that portion of stream expected to contain fish for a specific survey date.

Categories of Fish Occurrence

a/STREAM: Fish which occur and remain within the spawning area of a stream or which occur in a freshwater portion of a stream during spawning migration; this will also include fish observed in the mouth on the last survey of the year. These fish are not vulnerable to normal illegal fishing methods and means.

b/MOUTH: Build-up of fish in saltwater which is normally closed to commercial fishing. These fish generally are not vulnerable to legal fishing, but they may be vulnerable to illegal fishing. This category includes designated lagoons, as described in the closed waters portion of the Commercial Fishing Regulations. These fish are considered to be homing in on the stream for which they are documented and will be counted as fish in the stream on the last survey of the year.

c/BAY: Build-up fish, in saltwater which is normally either open to commercial fishing or closed to commercial fishing (closed water sanctuaries), which may be at least partially vulnerable to both legal and illegal fishing. These fish will not be included in the stream count unless special denotation is made in the remarks column and will only apply on the last survey of the year.

Table 5. Terror River aerial
survey results, 1988

Alaska Department of Fish and Game
Salmon Escapement Surveys, 1988
(Aerial Surveys Unless Noted in Remarks)

Stream	Date MM-DD	Observer	Visibility Str Mou Bay	-----Fish in Stream-----				Build Up Fish		Observer Remarks
				Reds	Coho	Pink	Chum	Mouth	Bay	
<u>Terror River</u>										
253-331	7-14	Malloy	f f g	0	0	500	1200	-	40000P 15000Ch	Looks good for this date. Water flow good.
253-331	7-21	Malloy	f f g	0	0	400	1800	-	58000P 20000Ch	Build-up looks excellent for this date. Water flow good.
253-331	7-26	Malloy	g g e	0	0	8800	5800	-	78000P 52000Ch	Chum build-up best ever seen. Return for both pinks and chums excellent. Water flow still good.
253-331	8- 4	Prokopowic h	e e e	0	0	71500	15000	52100P 4400Ch	23000P	-
253-331	9- 8	Prokopowic h	e e e	0	0	52900	10300	-	-	Gillnet full of dead salmon on Tidal Flats. Est. 1,000 fish in net. Above 4 mile creek 1,900 P, 100 chum, Mainstream 41,550 P, 9,000 chum, East Slough 5,000 pinks, 900 chum, Consternation 1,000 P, 100 chums, Bear Creek 0-blocked by Beaver Dam, Ouzel Creek 2,400 P, 200 chums.
Salmon Escapement Observations				Report Date 10/04/1989						

Table 6. Indexed even-year pink salmon escapements into Terror and Kizhuyak Rivers. 1960-1988

Year	Terror River	Kizhuyak River
1960	32,000	8,200
1962	50,000	8,000
1963	27,900	-
1966	86,000	8,000
1968	40,000	2,800
1970	40,000	12,000
1972	25,000	10,000
1974	69,000	4,200
1976	46,000	3,200
1977	33,500	1,800
1980	118,000	12,800
1982	39,000	23,650
1983	80,000	36,500
1986	196,500	32,200
1988	124,400	38,910
	\bar{X} 67,150	\bar{X} 14,450

Table 7. Chum salmon escapements, Terror and Kizhuyak Rivers, 1982-1988.

Year	Terror River Escapement	Kizhuyak River Escapement
1982	12,900	12,000
1983	10,050	3,170
1984	10,000	9,000
1985	3,000	7,000
1986	10,000	55,000
1987	15,000	17,000
1988	15,000	27,500
	\bar{x} 10,850	\bar{x} 18,650

Table 8. Kizhuyak River aerial
survey results, 1988

Alaska Department of Fish and Game
Salmon Escapement Surveys, 1988
(Aerial Surveys Unless Noted in Remarks)

Stream	Date MM-DD	Observer	Visibility Str Mou Bay	-----Fish in Stream-----				Build Up Fish		Observer Remarks
				Reds	Coho	Pink	Chum	Mouth	Bay	
Kizhuyak River										
259-365	7-14	Malloy	g g g	0	0	0	50	-	2000P 5100Ch	Water flow good.
259-365	7-25	Prokopowic h	e e e	0	0	0	0	1500P 19000Ch	15000P 50000Ch	Looks excellent for this time. Most fish by K.E.A. ramp.
259-365	7-26	Malloy		0	0	0	200	4000Ch	21000Ch	Chum build-up very good for this date. Water flow very good.
259-365	8- 4	Prokopowic h	g g g	0	0	12900	24800	-	-	Watchout - 700 chum. Above forks - 3,000 chum. W.F. 13,000 mixed pinks andchum - 60% chums. Chum creek - 2,000 chums. Beaver pond 500 P., 500 chums.
259-365	9- 7	Prokopowic h	g g g	0	0	0	0	-	-	Partial survey - 38,000 fish total. Mixed pinks and chums.
259-365	9- 8	Prokopowic h	e e e	0	115	26010	27500	-	-	Watchout Creek - 6,400 chum, 2,000 P, 15 coho. Beaver Pond 3,600 P, 3,600 chum. Chum Creek 5,200 chum, 500 P. Sloughs 4,300 pinks, 2,500 chum. EastFork 5,500 pinks, 5,600 chum. West Fork 9,600 P., 3,000 chums. Watchout Power house 510 P. 1,200 chums, 100 coho.
Salmon Escapement Observations				Report Date 10/04/1989						

Figure 1. Location of Terror River and Kizhuyak River, Kodiak Island, Alaska.

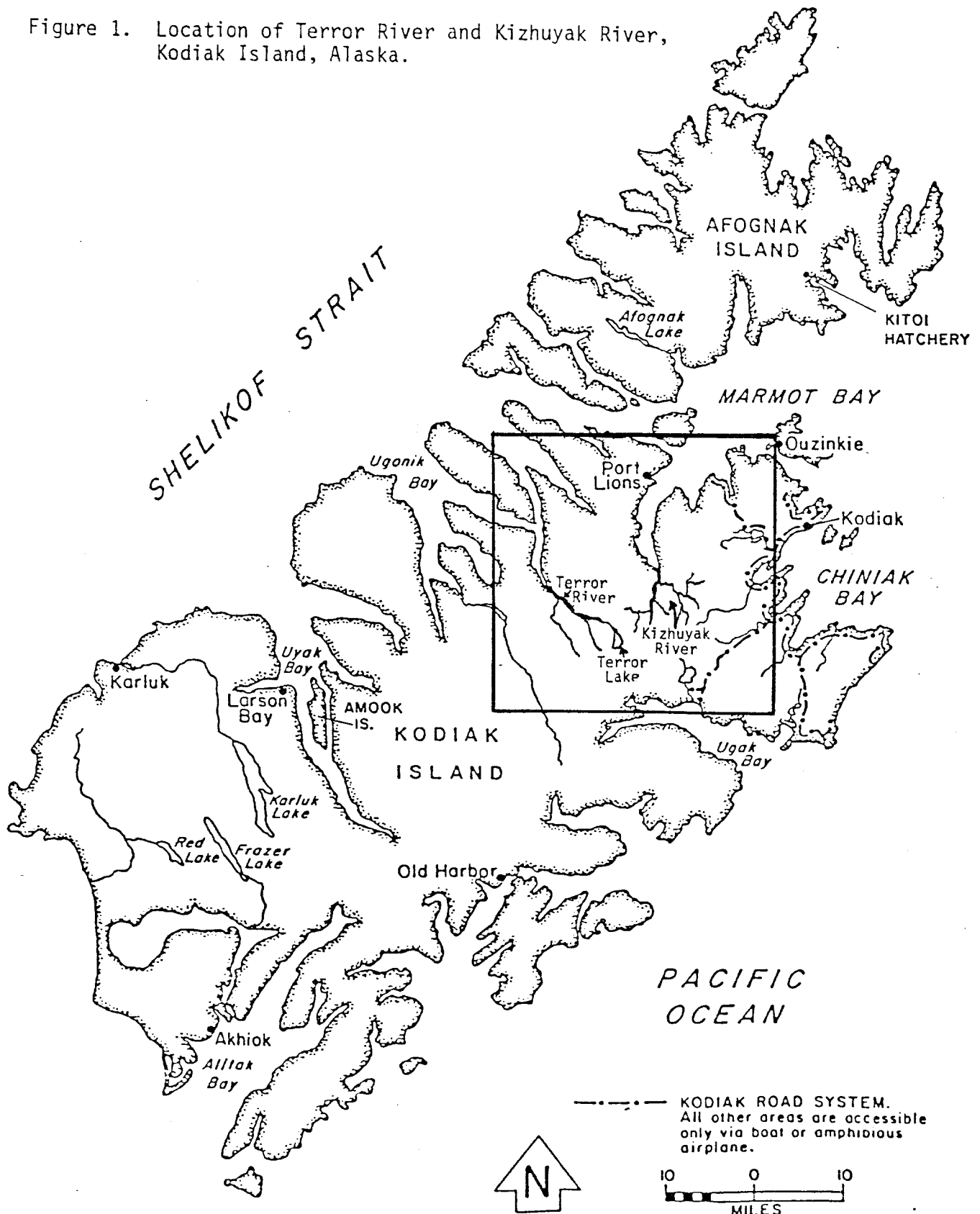


Figure 2. Terror Lake Hydroelectric Project.

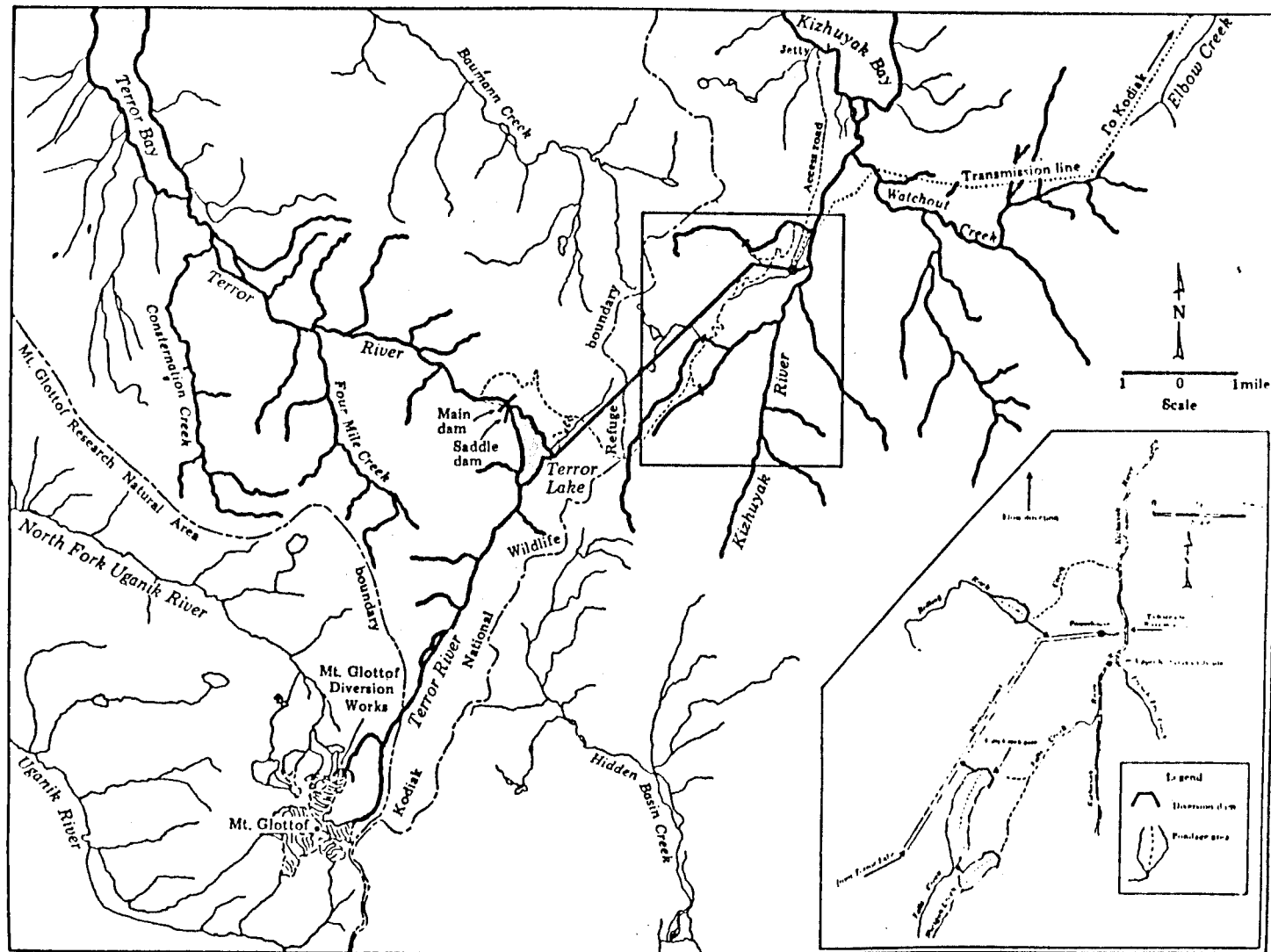


Figure 3. Terror River pre-emergent fry sampling sites, 1988.

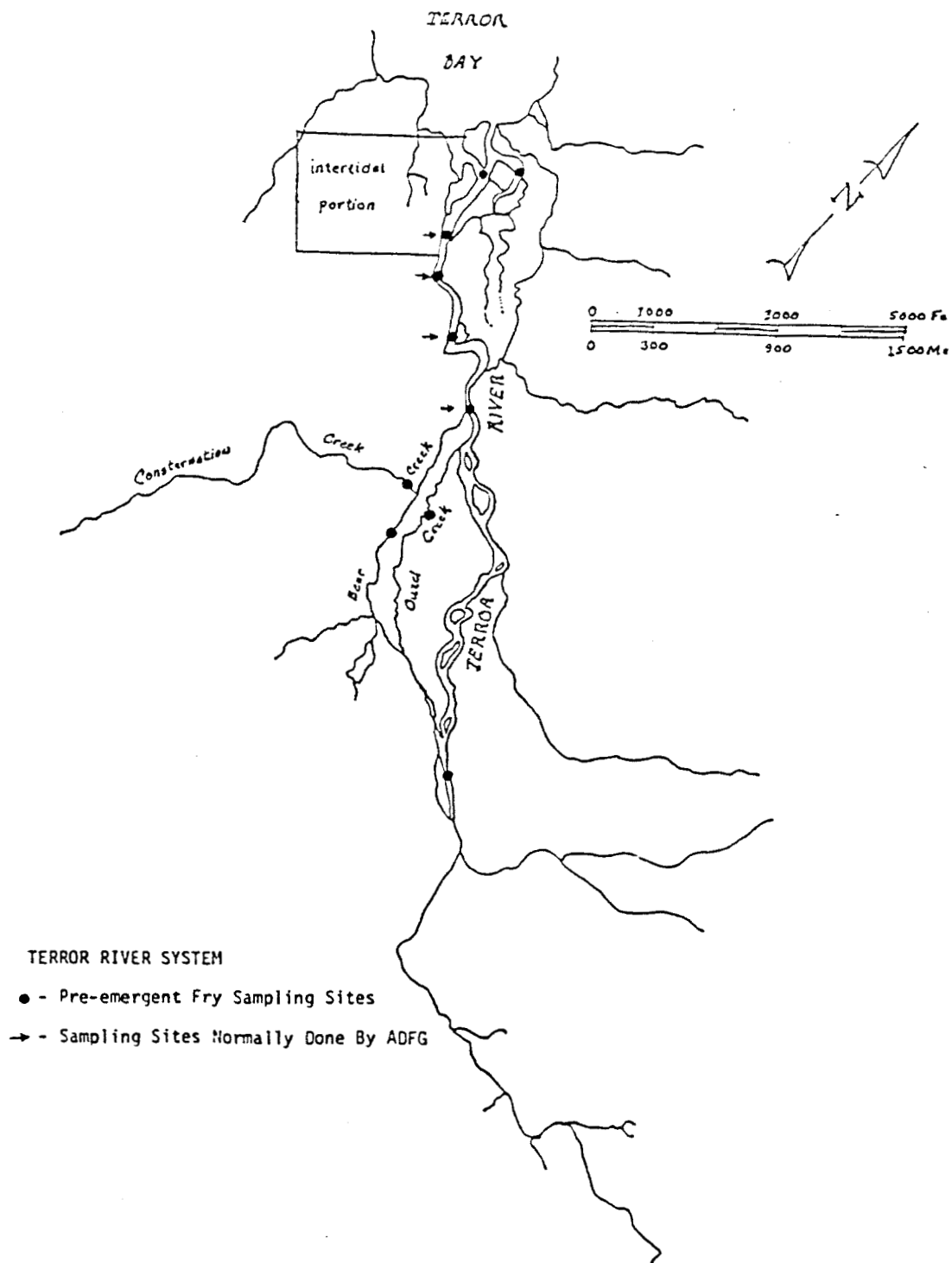


Figure 4. Kizhuyak River pre-emergent fry sampling sites, 1988.

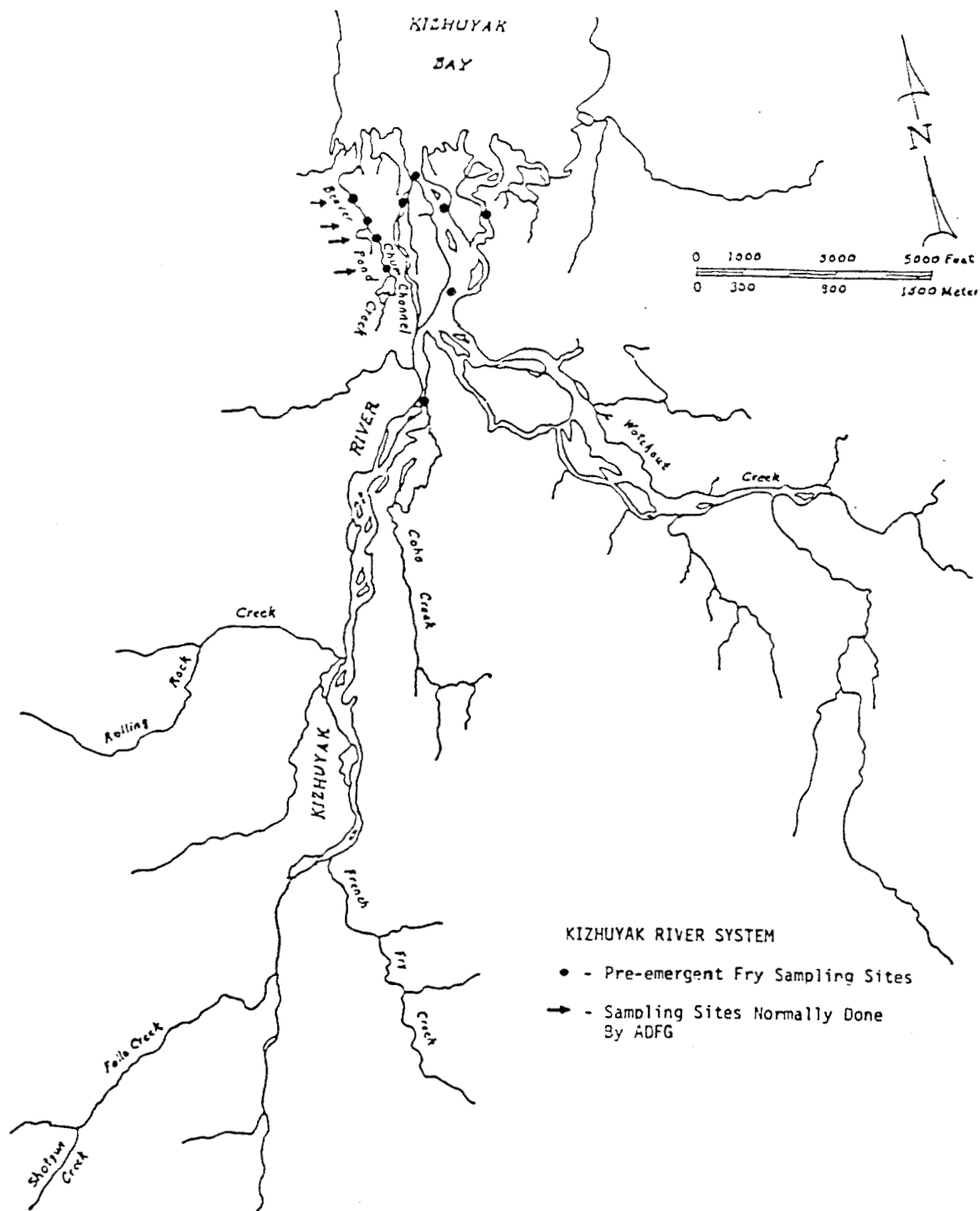


Figure 5. Terror River pink salmon distribution, 1988

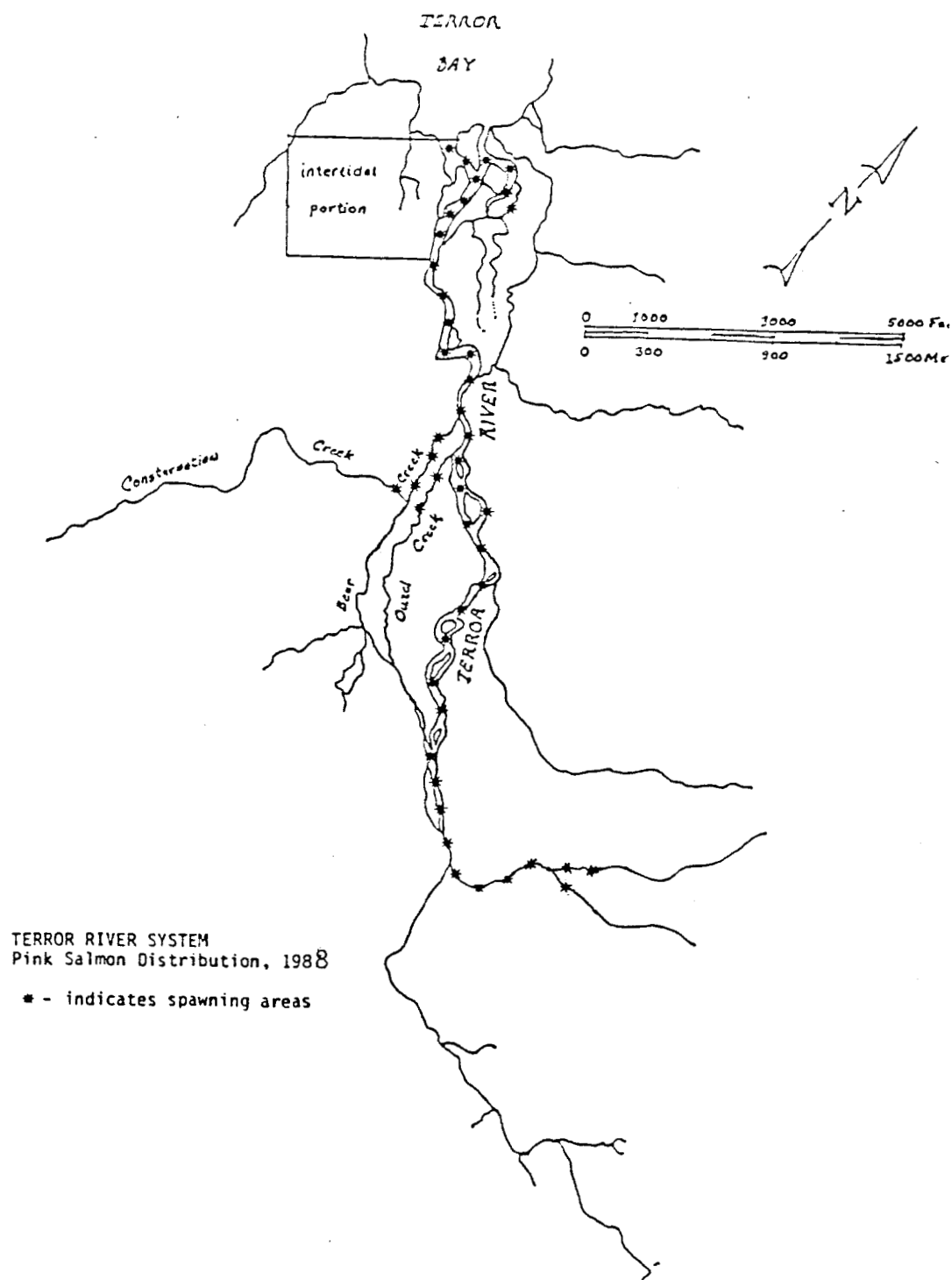


Figure 6. Terror River chum salmon distribution, 1988

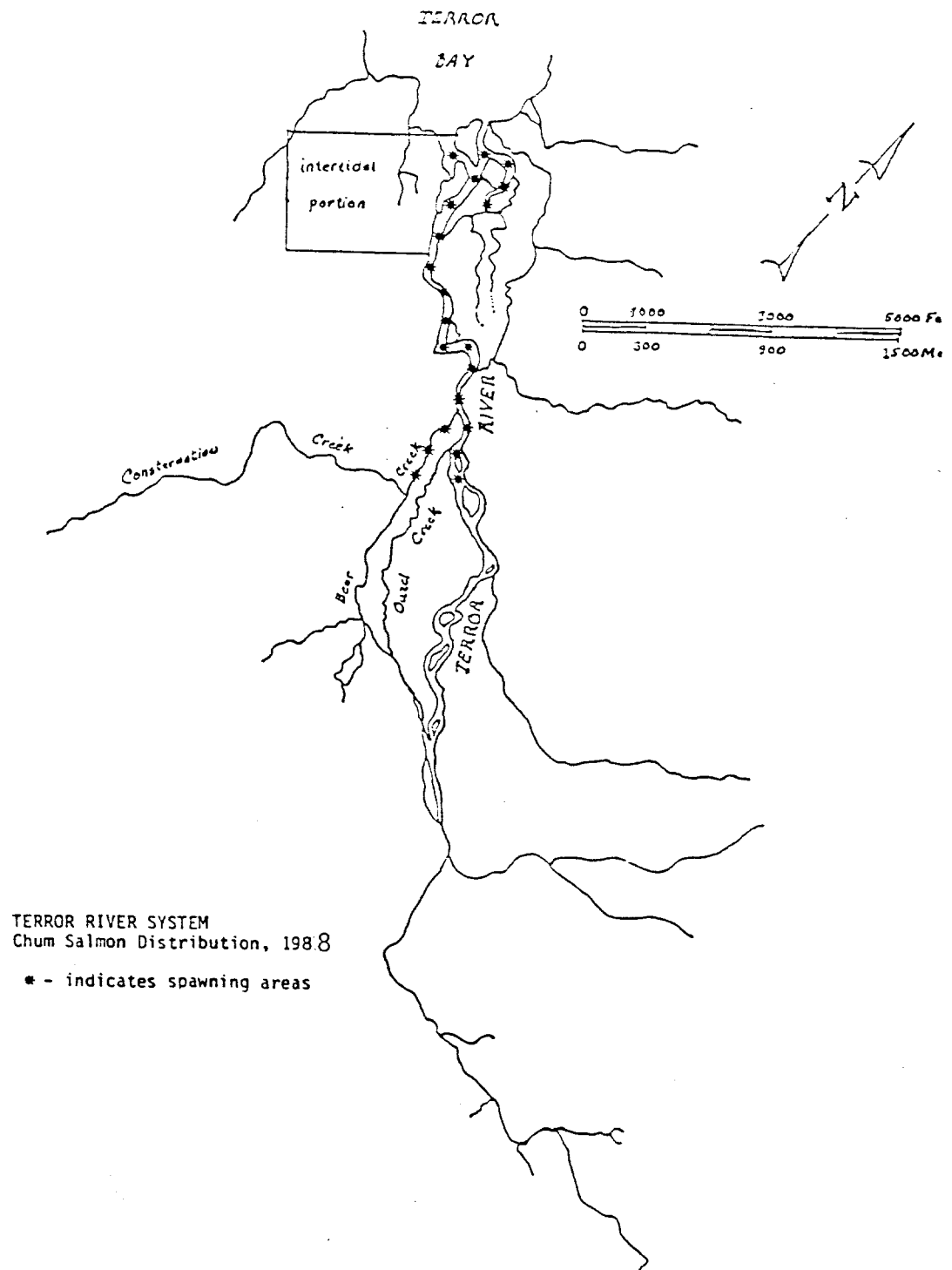


Figure 7. Kizhuyak River pink salmon distribution, 1988.

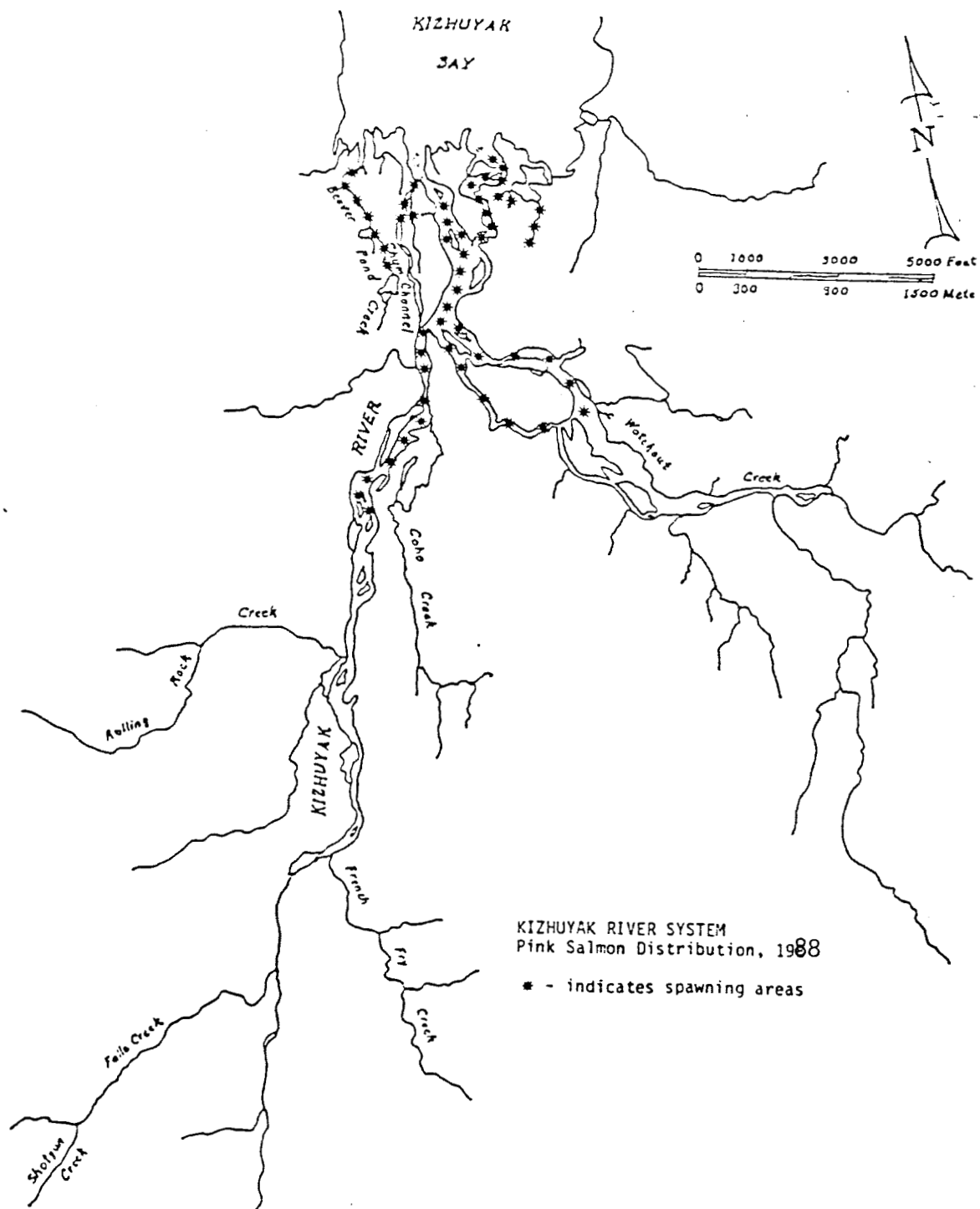
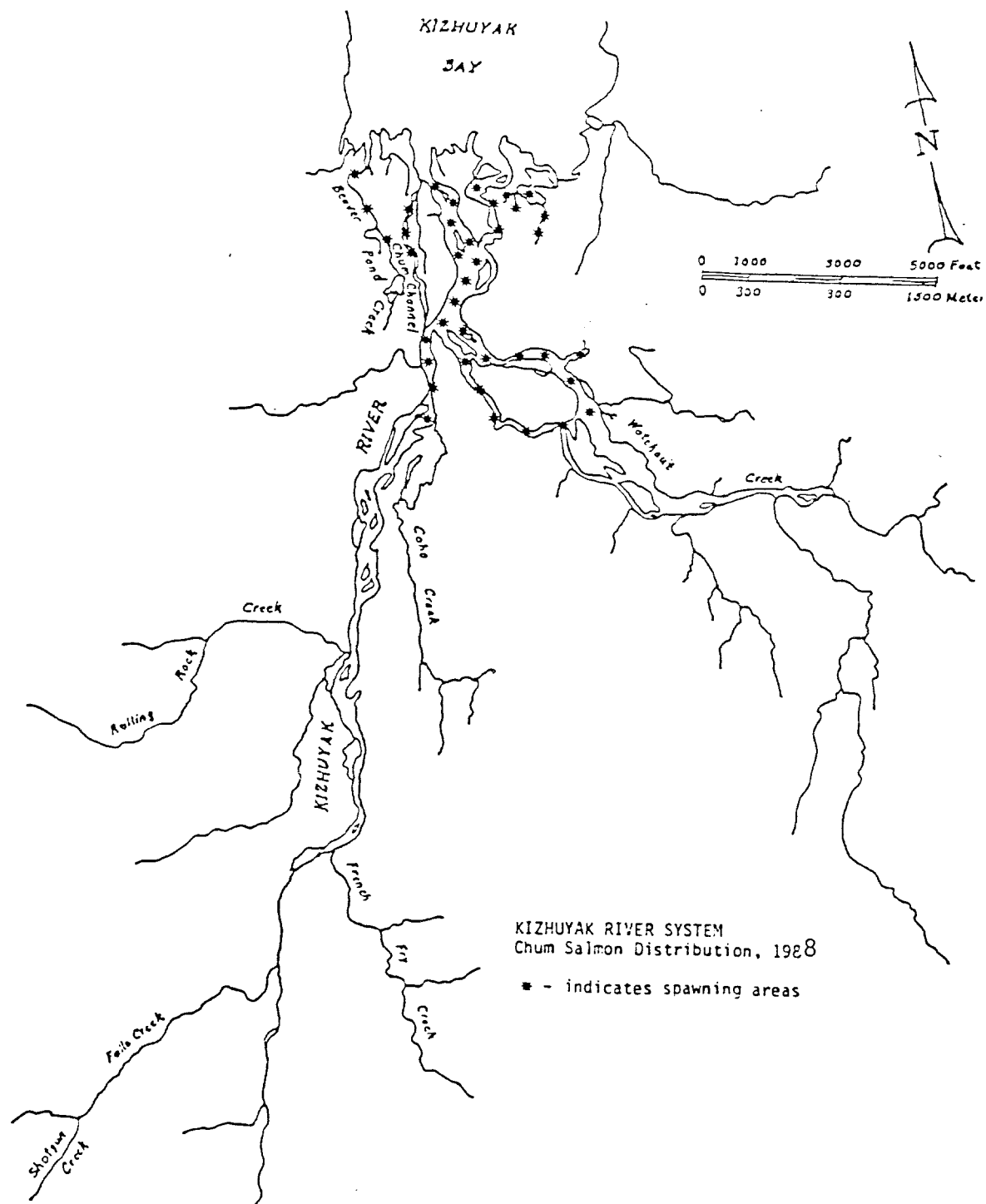


Figure 8. Kizhuyak River chum salmon distribution, 1988.



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Appendix A. Commercial Fisheries Division Expenditures, Terror River
Hydroelectric Project, 1987

DATE 01/01/80
PROGRAM ID ETSLEBAL
VERSION 3.0

ALASKA DEPARTMENT OF FISH AND GAME
LEDGER BALANCE SUMMARY FOR: 11039981 TERROR LAKE

LINE ITEM	ALLOCATION	EXPENDITURES	ENCUMBRANCES	PAID	OBLIGATED	CREDITS	BALANCE
100 - PERSONNEL	21,000.00	7,189.96	.00	.00	7,189.96	.00	13,810.04
200 - TRAVEL	300.00	.00	.00	.00	.00	.00	300.00
300 - CONTRACTUAL	5,000.00	2,067.00	.00	.00	2,067.00	.00	2,933.00
400 - COMMODITIES	750.00	1,198.09	.00	.00	1,198.09	.00	-448.09
500 - EQUIPMENT	.00	.00	.00	.00	.00	.00	.00
LINES 200 - 500	6,050.00	3,265.09	.00	.00	3,265.09	.00	2,784.91
ALL LINES	27,050.00	10,455.05	.00	.00	10,455.05	.00	16,594.95

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